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Which is it?

INSTRUCTIONAL TECHNOLOGY - U.S.C.

2879

NEW WORLD
OF
TEACHING MACHINES

OR

BRAVE NEW
TEACHING MACHINES

?

ED002497

by Ted Morello

UNESCO COURIER
MARCH, 1965

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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First grade primary school
children learn to read with
new teaching machine.

USIS

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AT a time when the field of education is in worldwide ferment, a single instructional phenomenon has captured the attention not only of professionals but of laymen. It is the so-called "teaching machine revolution" or, more properly, "programmed instruction".

Some of the striking achievements attributed to programmed teaching under experimental conditions help to explain the fascination that auto-instruction exercises:

Children two and three years of age have been taught to read and type... Without teacher, textbook or homework eighth-grade pupils completed a full year's work in ninth-grade algebra in a single semester... Three University of Michigan students were taught by machine to speak fluent Spanish in half the time required by traditional methods... Studying for seven hours a day, an eleven-man group learned as much Russian in 10 days as they would have in one and a half semesters of conventional college study.

Referring particularly to emerging nations, one authority says: "We are convinced that programmed instruction can work miracles... in solving the world's educational problems."

10 A "programme" consists of instructional material designed to lead a pupil almost unaided and without error to a pre-selected level of learning by what amounts to a Pavlovian stimulus-response-reward pattern. Behind any programme lies the theory that the material must start with

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something familiar to the student and progress with increasing difficulty through steps so small that the student can move forward alone with reasonable assurance of responding correctly. A programme may be presented in book form or by mechanical devices (hence the designation, "teaching machine").

As a practical matter, programmed instruction has not yet progressed beyond the tentative, experimental stage. There are those who contend that it never will, for nothing approaching unanimity exists in academic reaction to this unknown quantity clamouring for acceptance.

Few innovations in teaching have generated so much debate. At one extreme are those whose missionary zeal for teaching machines borders on fanaticism. At the other are those who, for a variety of reasons, condemn them just as enthusiastically. In between is the overwhelming bulk of educators—uncertain, cautious, even suspicious, but hopeful, too, and eager to believe that here at last is a sign pointing down the royal road to learning.

By recent count there were in the United States alone well over 100 companies in the teaching machine field, and the number is growing. Considering this mechanical explosion, it is not surprising that educators don't even agree on what is and what is not a teaching machine. However, a definition by Dr. Douglas Porter, a programming authority at Harvard University, is fairly representative. Teaching machines, he says, are "devices which endeavour to alter



the course of learning by automatically presenting the student with a 'reward', or reinforcement, immediately after he has made a correct response... All these devices possess three operation characteristics: (a) they present a sequence of problem materials to the student; (b) they provide some means by which the student may record his solution to the problem; and (c) they automatically and immediately indicate correctness of the solution."

The fact that a student is responding frequently in an explicit manner gives him a constant check on what he is learning. Unlike a lecture situation, his active participation makes any lapse of attention immediately apparent to him. The impact of correction is infinitely greater because it comes immediately instead of days or weeks later, as in the case of written examinations. Finally, the immediate confirmation of correct response rewards and stimulates the pupil to further efforts.

One of the most striking features of auto-instruction is the fact that a student may move along at his own pace—neither held back by slow-learning classmates nor precipitated into an area for which he is unprepared.

Dr. B. F. Skinner, a Harvard psychologist who used laboratory pigeons to demonstrate the step-by-step learning that underlies teaching machine instruction, adds this important point:

"The machine itself, of course, does not teach. It simply

brings the student into contact with the person who composed the material it presents. It is a labour-saving device because it can bring one programmer into contact with an indefinite number of students."

The Center for Programed Instruction, a nonprofit educational organization in New York City that acts as a worldwide clearing house for information in the field, puts it this way:

"A teaching machine has been likened to the binding of a book. Therefore, if a child learns anything, he will learn as a result of the material in the machine (i. e., the programme) rather than as a result of the teaching machine itself. The machine in actuality has very little to do with the process, and is in many cases unnecessary."

Indeed, research indicates that the mechanics of programme presentation—whether by book or machine—has little effect on results.

The mechanical aspect of programmed learning is a particularly sensitive one. Advocates of the system shy away from the term "teaching machine" in favour of "programmed learning", "automatic tutoring", "auto-instruction" or "psychomotor self-instruction". (The more implacable critics scoff at the system as "instant knowledge" or "canned genius.") Nevertheless, "teaching machine" persists among laymen as the most convenient and common designation.

CONT'D ON NEXT PAGE

Students given every chance to be right

A teaching machine may range from a device scarcely more sophisticated than the traditional student work book to a complex mechanical and even electronic tutor that presents not only written but audio-visual material. There are about 100 models in various stages of development, of which about half are in limited or full production.

Regardless of simplicity or complexity, a teaching machine is only as effective as the programme—the instructional material—that it presents to the pupil. As Prof. Robert Glaser, who has devised programme books at the University of Pittsburgh, observes:

"The fact that it is a difficult and aversive task to programme material and a much easier task to build the accompanying hardware is indicated by the fact that at the present time machines outnumber programmes by a large factor. We are in the situation of having shells without innards."

That point was underscored when a school board spent \$5,000 for 20 machines—and then discovered that no programmes were available for them.

MOST researchers are satisfied that there no longer is any doubt that programmed teaching is effective. ("Even a bad programme is a pretty good teacher", one experimenter says.) Emphasis now has shifted to making programmed teaching efficient—to preparing material that will guide a pupil in the desired direction without meaningless or even damaging departures.

A sound programme is one that has been prepared meticulously and tested rigorously. A programmer first tries it out on a single student, changing a word or phrase or adding or eliminating sections until the desired response emerges. One by one, as many as ten other students work through the material, which again is revised as necessary. Finally, the programme is group-tested. Ideally, it is then capable of teaching efficiently perhaps ninety-eight per cent of all students who are intellectually on a par with those who participated in the testing programme.

Wilbur Schramm, director of the Institute for Communications Research at Stanford University, says there has always been a "deadly inflexibility" about the age at which the average student was considered ready for any given instruction. Underscoring the necessity of meaningful programming, he then asks rhetorically:

"But suppose that readiness depends upon teaching method as well as upon subject matter. Suppose, for example, that a student is ready for the usual way of teaching geometry only in the tenth grade but is ready for another way of teaching it as early as the second grade? Suppose that, as in the Soviet Union, intelligence tests were to be minimized; and when a child could not understand an explanation or a concept, the blame were to be laid, not on the child's supposed lack of intelligence, but at least partly on the way the material is being taught? Suppose the testmakers were to think of their assignments not as selecting the fit from the unfit, but rather as selecting the kind of instructional methods which will fit different kinds of individuals?"

Programming falls into two broad categories: linear and branching. A linear programme tries to guide the student step by step toward a correct response, even prompting him with thinly veiled hints. Dr. Skinner, a principal proponent of linear programming, says:

"Teachers generally want students to be wrong. If everyone knows the answer to questions, teachers make them tougher. With teaching machines, you give the students every opportunity to be right."

In the branching approach the pupil who responds with the right answer moves along the trunk route to the next question. But if he responds incorrectly, he is detoured over explanatory material that provides the background to correct his error. As he absorbs the subsidiary material, he is led back, question by question, to the mainstream of instruction. In other words, the student is either presented with remedial material or accelerated to more advanced material.

Programmed textbooks are by far the mostly widely used presentation method—indeed, virtually the only one in curricular use. This despite one major distinction between machine and text that favours the former. As one research team has pointed out: "With programmed texts, nothing but his conscience prevents the subject from gaining access to the correct answer prior to making his own response." Machines, on the other hand, are designed to be cheat-proof, mechanically serving up problems one by one and masking answers until the student has irrevocably responded.

Other devices for presenting the curriculum material include memory drums, rotating disks, film sequences, slides, index cards and magnetic tape recordings.

In terms of Dr. Porter's "operation characteristics", how a problem is presented depends on the design of the machine; but in general the problem ranges from short statement or question to a number of paragraphs presented either visually (film, television or in writing) or orally (by recordings) or both. The device then may either wait for the learner to respond before reacting (learner-paced) or it may move on to the next question at the end of a predetermined period of time (machine-paced).

THE second step—student response—may be taken in a variety of ways, again depending on machine design. The student may write a word or passage, punch a hole, push one or more buttons or indicate his reaction in some other way. Answer mechanisms tend to polarize toward "multiple-choice" on the one hand and "constructed response" on the other.

The final step—confirmation of the solution's correctness and reinforcement (reward)—likewise depends in form on the device used. Generally, revealing the answer by exposing more of the programme both grades a student's response and (when he is right) rewards him sufficiently. However, the reward may also sometimes take the form of flashing lights, bell-ringing, audio-visual evaluation, or—particularly for younger children—the vending of candy, marbles or small toys.

The boy at the typewriter is studying oceanography. The typewriter is part of a teaching machine used to demonstrate current research on the human learning process. A series of lessons and questions about oceanography appear on the screen before the student. He reads and responds by using the typewriter to answer the questions. The order of succeeding lessons depends on the appropriateness of his answers previously programmed in a digital computer.

USIS



Here is the step-by-step operation of one simple auto-instructional device programmed for basic arithmetic. The device consists of 12 sheets packaged in a cardboard folder. A window in the folder exposes a portion of one sheet: a box (or frame) containing one question or instructional paragraph or both, and a second box left blank for student response. When he has completed frame 1, the pupil slides the sheet upward to frame 2, exposing the answer to frame 1, plus a new question or instructions and second box for the written answer to question 2.

Frame 1, for example, reads: "In arithmetic, we must understand numbers and what they mean if we are to get correct answers".

Because this is instructional material rather than a question, the "answer" box merely instructs: "Go to the next frame".

Frame 2 reads: "When we u.....d numbers in arithmetic we will get correct answers. Fill in the word". In the adjoining box the pupil is expected to write, "understand". He then moves the sheet upward, exposing frame 3 which contains the correct answer to the frame 2 question and presents the new instructional material: "We call the way numbers are put together a system". Frame 4 reads: "When we understand the number system, we will get (right/wrong) answers. Choose the right word. In the answer box the pupil writes, "right"—and, is

rewarded when, on moving to frame 5, the word "right" is exposed as the correct response to the frame 4 question.

At its most revolutionary, programmed teaching not only guides a pupil through what to learn but shows him how to learn. The distinction is roughly equivalent to that between a lecturer and a tutor. Both provide facts, but the tutor additionally helps the student to learn them.

Since the system focuses on guiding a pupil to a correct response rather than trapping him into a wrong one, prompting is an integral part of programming. As specific examples of good and inadequate prompts, Dr. David J. Klaus, associate programme director for training and education at the American Institute for Research, in Pittsburgh, lists the following problems:

Example X: "Fahrenheit and centigrade are scales of temperature; Kelvin is a"

Example Y: "Fahrenheit and centigrade are scales of temperature; Kelvin is also a"

Dr. Klaus observes that example X is a poorly cued frame resembling "a test question rather than an aid to learning".

"By adding a single word, however, example Y illustrates a very good frame", he says. "It is almost impossible for a student to answer it incorrectly even if has never seen the word 'Kelvin' before."

What can be expected from auto-instructional devices?

CONT'D ON NEXT PAGE

Too costly for emerging countries ?

Three levels of programmed learning are usually mentioned. At the lowest is so-called rote learning of such material as vocabulary, arithmetic, spelling and the basic facts of history and geography. A step higher is conceptual learning in which a student not only must memorize facts but must be capable of handling a wider variety of problems and examples than can be specifically covered by the programme. Physics, statistics and economics present challenges in this direction. The most sophisticated instructional level involves the teaching of such capabilities as creative thinking and judgement.

"This may be the level of education at which auto-instruction will yield its greatest fruit", says Dr. Klaus. "The possibilities of developing a programme in this area are derived from two simple observations. First, we have sufficient data to indicate that creativity and judgement are examples of learned behaviour. Secondly, we have evidence to indicate that these behaviours can be taught. What is left is simply a problem of mechanics, that is, identifying exactly those behaviours to be learned and then finding the means to successfully establish these behaviours in the student's repertoire with auto-instructional methods and devices."

Yet it is precisely at this point that many educators split with teaching machine enthusiasts. For while conceding the device's role in purely quantitative teaching, they are dubious about a machine's effectiveness as an instructor in qualitative subjects.

In terms of the number of programmes available, the field is dominated by mathematics, which lends itself to programmed instruction because it is a subject of precise answers that can be learned in small steps. English, including reading and spelling, is probably second, followed by psychology, foreign languages and physics.

Dr. Edward B. Fry, a teaching machine researcher at the University of Southern California, remarks:

"It is probably quite safe to say that in the next few years some programme will have been developed for every subject taught in our schools."

A contrary view comes from Dr. George D. Stoddard, chancellor of New York University. He accords the machine a place as an instructor in facts, formulas, vocabulary and grammatical rules. But he fears that such instructional methods will stultify rather than stimulate a child's thinking, creative and performing processes.

"Perhaps a live teacher who infuriates a student is better than a machine that leaves him stuffed with information but cold as a mackerel," Dr. Stoddard says.

Much of the hostility toward auto-instruction is based on economics; despite assurances to the contrary, many teachers fear that machines will replace them. One so far betrayed his hostility as to fail thirty per cent of a class that had come to him via a programme-taught preliminary course. And in at least two cases, indignant school administrators have demanded legislation barring programmed instruction from classrooms.

14 Among parents and laymen generally, opposition is often based on sentiment—the fear that "traditional" relationships between pupil and teacher will be destroyed.

Both categories of opponents visualize varying degrees of automation, ranging up to the extreme of a 100 per cent mechanized educational system from kindergarten through university.

Proponents of the system scoff at such fears as groundless. They reply that, with or without machines, programmes can liberate teachers from the drudgery of purely mechanical instruction so that they may be free for "those inspirational and thought-stimulating activities which are, presumably, the real function of the teacher," in the words of Dr. S.L. Pressey, the Ohio State University psychologist generally regarded as the precursor of the teaching machine revolution.

ONE educator has said in the machine's defence: "A human being should not be wasted in doing what 40 sheets of paper or two phonographs can do. Just because personal teaching is precious and can do what books and apparatus can not, it should be saved for its peculiar work. The best teacher uses books and appliances as well as his own insight, sympathy and magnetism."

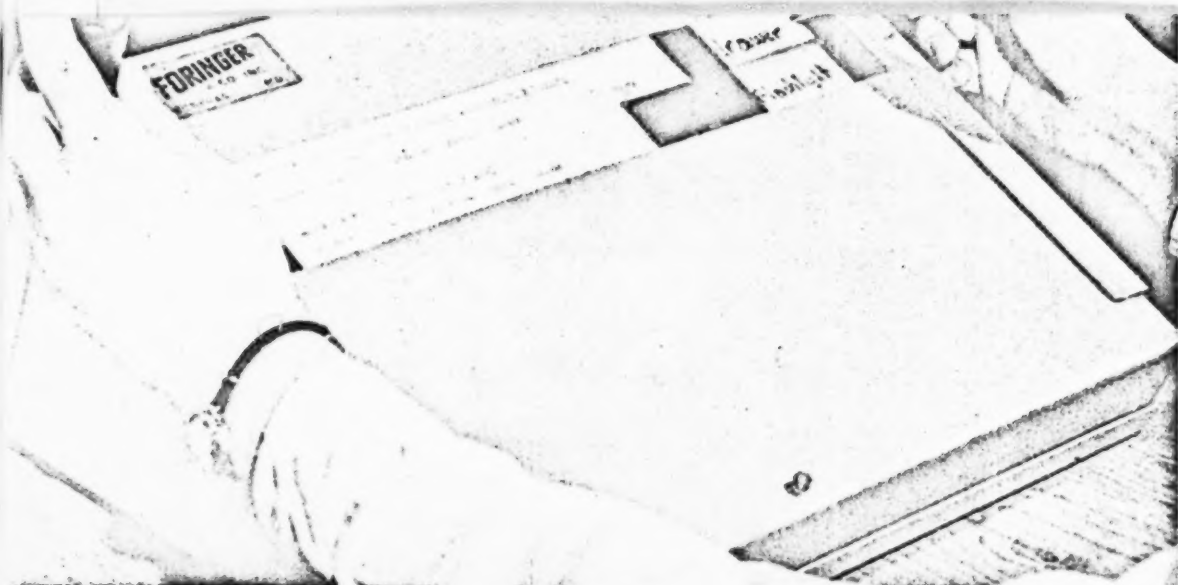
Auto-instruction would be irresistible even if its only promised advantage were an impressive speedup in educating the world's children. (Dr. A.A. Lumsdaine, an education psychologist at the University of California, Los Angeles, predicts that with machines, "bright pupils will be able to finish the grade school curriculum by the time they are 10 years old instead of 14"). The fact is, programmed instruction is enormously attractive for other reasons.

In a world clamouring for more and more teachers, programmed learning seems to offer a way of spreading out the available supply. And with the soaring cost of elaborate school buildings beyond the reach of impoverished and even of many advanced nations, machines which can be used in buildings of monastic simplicity or even at home seem to be a budgetary blessing. Attracted by these and other considerations, educators from Latin America, Asia, Africa and Europe are eagerly watching developments in the field. The first experimental steps already are being taken in Sweden, France, Great Britain, Japan, West Germany, South Africa and Nigeria.

Prof. Arthur French of Makerere College in Kampala, Uganda, admits that there is widespread interest among African educators; but he adds that many administrators are intimidated by the cost of teaching machines. Programmers not affiliated with commercial "teaching machine" manufacturers tend to agree that emerging countries would be unwise to invest heavily in mechanical devices now. Says P. Kenneth Komoski, president of the Center for Programed Instruction:

"We are not going to help a country that is trying desperately to create or acquire traditional textbooks by telling them we have better books that cost more (as indeed they do). In fact, the less emphasis we put on the products of programmed instruction, i.e., programmed texts and teaching machines, the better off we will be. For one thing, teaching machines will not work in developing countries today for the simple reason that they do not work in this country. They simply have not been sufficiently debugged... I believe we would be foolhardy to chance mechanical failure so far from home."

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A simple teaching machine operated with a typewriter roller action. Student writes answer to question in window on right and can go on to the next question if he is correct.

From "The World of Teaching Machines"
© 1961, Electronic Teaching Laboratories,
Washington, D.C.

TEACHING MACHINES (Cont'd)

A new technique of unlimited potential

For the immediate future, Mr. Komoski suggests, emphasis should fall on "finding out how the principles of programmed instruction may be generalized to all instructional situations and applied to all available media" regardless of culture. Such an approach is aimed at solving two great unknowns about the prospect of worldwide use of programmed instruction: (a) To what extent can programmed instruction, still an almost wholly American phenomenon, be transferred merely by programme translation to another nation—even an English-speaking one? (b) How many of the principles applicable to American-oriented programme instruction would be valid in constructing indigenous programmes in other languages for peoples of other nationalities, cultures or educational levels?

While admitting that almost nothing is known about programmed instruction except that it works, educational psychologists in the field nevertheless are confident that it is a new weapon of unlimited potential in the worldwide war against ignorance. Pointing out that the global need

for teaching of literacy and technology "is so vast as to be almost beyond comprehension," Dr. Schramm says:

"Could an intelligent use of programmed instruction significantly reduce the time and money required for that task? Everyone who is familiar with programmed instruction and has looked closely at the needs of the new states is most optimistic about what could be accomplished. These countries are desperately short of teachers; here is a device to multiply good teachers. These countries have unusual motivations to learn; here is a device to take advantage of these motivations and provide a tool for self-teaching. These countries have need for a considerable amount of expert and specialized teaching which is often not within the competence of many of their teachers. Countless one-room schools are in charge of teachers who themselves have only four to six years of education. How much the learning opportunity of those one-room schools could be increased by the addition of a small library of well-made programmes."

Unesco 'workshops' on programmed instruction

FOR several years Unesco has been studying the possibilities of introducing programmed instruction in developing nations. In 1963 it held "workshops" on programmed instruction in Rammallah (Jordan) and Ibadan (Nigeria) to introduce to educators in the Middle East and West Africa the techniques of programming instructional materials. In 1964 another workshop was held at Accra (Ghana) and a work conference took place in Zaria (Nigeria). Programmed instruction materials were also developed in 1963-64 in Sao Paulo,

Brazil, where a Unesco pilot project on physics teaching was launched. In 1965 two workshops are planned for French-speaking African countries (in Madagascar) and for Arab educators concerned with teacher training. For further information on programmed instruction and other new techniques in education see "Programmed Instruction in West Africa and the Arab States" and "New Methods and Techniques in Education" (Nos. 52 and 48 in the Unesco publications series "Educational Studies and Documents"; \$1.00; 5/-; 3,50 F.).